

*Sponsored by the Office of Naval Research (ONR)*

**ONR Decision-Support Workshop Series**

# ***Developing the New Infostructure***

hosted by the

**Collaborative Agent Design Research Center (CADRC)**  
**Cal Poly State University, San Luis Obispo, CA**

***Proceedings of Workshop held on September 10-11, 2003***

***at***  
***The Clubs at Quantico, Quantico Marine Corps Base***  
***Quantico, VA***

December 2003

## **Demonstration of a Typical Ontology-Based Collaborative Agents System: SEAWAY**

**Col. Tony Wood (USMC Ret.) and Dr. Jens Pohl**  
Collaborative Agent Design Research Center  
Cal Poly, San Luis Obispo, California

### **SEAWAY: Advanced Decision Support to Expeditionary Operations**

Do you know what a parable is? When you're over 50 you don't tell jokes. You tell parables. Bear with me a moment for a parable.

The shadows were lengthening in the swamp and the bunny rabbit came hopping down the trail and the blind snake came hopping down the trail. And the blind bunny rabbit smacked into the blind snake and they recoiled, and the blind bunny said, "Who and what are you?" and the snake said, "I don't know. Who and what are you?" And so they decided to find out. And slowly that snake wrapped himself around that bunny rabbit and he said, "You've got large ears to hear with and a bunny rabbit tail and rabbit whiskers and big hoppers. I think you're a bunny rabbit." And the blind bunny rabbit said, "Oh what joy! This is the greatest day of my life! I know what I am! Now, let's find out what you are." And very slowly that snake uncoiled and lay down on the dust of the trail and the bunny hopped over and reached out: "Cold skin, small beady eyes, speak with a forked tongue, no visible sex organs...I think you're a lawyer!"

In the ten years that I have been working on decision making you're never quite certain what the outcome of what you start is going to be. And the law of unintended consequences is very much alive and well, particularly in developing new applications for decision support. Today I am going to provide a quick overview of the SEAWAY decision support system.

In San Luis Obispo we have seventy-seven SEAWAY systems which are being prepared for fielding, and we are deep into the design of the follow on version. So, we are discussing a decision support system which is operational. Before we explore SEAWAY, we probably ought to talk about defining decision making problems and applying decision support.

In the case where the senior decision maker has poor decision skills, even the best decision support will make only the most marginal of difference. However, good decision support can make a huge difference if you have just an adequate decision process and adequate decision-making skills at the top. But without adequate decision-making skills supported

by an adequate decision process, all the decision support in the world won't make much difference.

My second observation on the design of decision support systems is that we have to be careful not ask the computer to do something which it doesn't do well. Not because it's unfair to the computer, that's nonsense – but because it will undercut our own mission and deceive us.

Computers don't conceptualize. Point one. They don't have intuition. Point two. And, three, they do not do well in analyzing subtlety on the modern battlefield in terms...especially in terms of urban operations and political considerations. With this in mind, we need to be careful when we talk about decision makers not forget to use this very elaborate massively parallel processor we've got up here on the top of our neck to assess the subtlety of the battlefield and the campaign.

Now, when conducting seminars at the Naval Post Graduate School in Monterey, I compare the battlefield that existed prior to Afghanistan with the battlefield that exists today. Consider just a few of the contrasts with which we are now faced – but which are not reflected in our decision support tools most of which were developed in the Cold War period. The gross battlefield of the north German plain, large forces, no ROE, very, very large movements, few or no rules. A battlefield where precision was not critically important, and one that rewarded mass, depth, and size. The characteristics of this cold war framework defined United States military decision support initiatives and, to a very large extent, continue to do so today. However, we have a problem; this defining battlefield has disappeared to be replaced by one which is quite different.

Although the “E” word is not fashionable, we are closer to dealing with a situation as a military which is more akin to the British situation between 1814 and 1914 than we are to any other period I can think of. So if that's the case, if we're dealing with subtle battlefields with political and military mixtures in places like Afghanistan and Iraq and elsewhere, then we also need to remember that the individual decision-making skills from private to general are probably as important as decision support and deserve at least as much attention.

Second point: Military decision support systems are designed for experienced professionals – not amateurs. Decision support systems are not designed to raise the incompetent and inexperienced to an adequate level. The systems are designed to be leveraged by experienced professionals who understand both the limitations and the strengths which the computer offers. The poorly trained and the inexperienced will substitute slavish dependence for calculated evaluation of results.

Third point: There's a moral dimension to the relationship between a decision support tool and the decision maker. Depending on where you come from, you will agree or violently disagree with my next couple of comments. However, in my view, we must never place the computer between the decision maker and the responsibility to make a decision –

especially one involving a decision on life and death. Never. When we do that what have we done? There is no longer a linkage between the person and the action he or she has directed. There's no linkage between the decision to take violent action and the consequences. If the computer is between me and that decision, then all I did was exercise the computer. At any rate, I think what I have expressed is largely a Marine Corp point of view, but it's one that I believe is well worth thinking about.

For the last three years I've been working with about thirty Navy and Marine officers designing and building SEAWAY, a decision support tool for the MAGTF, the Joint Task Force, and for expeditionary warfare in general.

SEAWAY's design combines human strengths with computer strengths in a collaborative framework. On the human side the system design assumes that conceptualization will come from the user. It is in the design of the system architecturally. Secondly, the design assumes that the generation of a conceptual scheme of maneuver and its description will come from a human because this sort of conceptualization is a uniquely human skill. The design assumes that the computer will provide the ability to track hundreds of thousands of items. It assumes that the computer will stand back-to-back watches without getting tired, and that the computer will rapidly convert our conceptual schemes of what the force is going to do into the logistics and the delivery of "how" it's going to do it. So, architecturally, the design "leads to strength." When you build a decision support tool "you must "lead to strength" and combine the human strengths with those from the computer. Don't ask the computer to do what it can't do (such as conceptualize) any more than ask us to track thousands of items individually.

SEAWAY provides tools to support the Joint Task Force and MAGTF at the operational level of war. Why the Joint Task Force and why the operational level? Because we have turned "TPFDDing" into a cottage industry. Because we have spent the last 15 years building strategic tools which we've rarely used. Because we have focused on the strategic level of war rather than the operational because it is easier to deal with. Because we have done very little to help the force where war is actually waged -- at the operational level. Because there are no tools for the Joint Task Force commander. Because he has no capability to analyze theater logistic posture and compare it to the support needed for his intended campaign. Because he has no capability to translate his intentions into what it may take to support them. None of the tools needed to support these functions exist. And, even as we discuss the absence of these needed tools we are standing up permanent joint task force headquarters. Amazing, isn't it? Well, that's why we built SEAWAY.

With these thoughts in mind, I went to ONR about three years ago with a vision and said, "Look, we're talking about supporting widely dispersed operations at deep inland locations whether the focus is Army deep maneuver or Marine operational maneuver from the sea, or similar joint concepts. We're proposing inserting forces and supporting them at great distances inland in joint and coalition operations. That means that the forces will be supported at the end of a helicopter-borne umbilical. That means that as fast change occurs (and the only certainty on the battlefield is continual change) we're going to be forced to recalculate the support requirement. Think about Iraq. Think about the first Marine

division's march to Baghdad. Think about how often unanticipated even by the wildest of planners that constantly changing operational requirement had to be altered.

As I said, the only certainty on a battlefield is change. You can be certain everything's going to change and that the plan is going to be great until the first shot is fired and not a second farther. After that it's a new plan. So, the underlying assumption in we built into SEAWAY is that everything will change all the time. This new decision support tool would be built to provide recommendations in the face of continuous change.

So, we can establish several characteristics, which SEAWAY had to have. First, lead to strengths, human and computer. Second, provide assistance in a familiar fashion (Don't give staffs a tool that has a whole new face on it). Third, provide *flexible* tools. Why? Because we don't know what the force is going be faced with. We don't know the kind of campaigns. Nobody would have predicted Afghanistan or Iraq in 1998. They might have predicted other things, but those two wouldn't have been at the top of the list. So tools which can *adapt to any situation...* because we can't predict what the operating forces will face. Fourth, compliment the established planning process. Provide tools which compliment what our forces already understand and exercise. Fifth, make the tools collaborative. In December 2001 five staffs employed SEAWAY at separate locations simultaneously for three days. All at the same system at the same time from four or five different locations. Sixth, make it fast and accurate. Identifying change isn't the battlefield objective – the objective is *spotting its implications and exploiting it before the other guy can*. Finally, seventh, make it *useful*. Not only do the JTF's not have any tools, but many of the tools we've given them are either so difficult to use or so trivial that they don't use them. Decision support should deal with very difficult issues in complex decision situations in a fashion familiar to the user.

Constant change. I mentioned that the underlying assumption in SEAWAY's design was dealing with continuous battlefield and theater change. What sort of change? The *resources* available to the Joint Force Commander change continuously as consumption and re-supply exercise their opposite effects. The *battlefield itself continuously changes*, whether it's a battlefield like Iraq, or whether it's something far less well-defined such as Afghanistan, or a combination of both. The friendly, enemy, and neutral elements are all dynamic. As a result of these factors and others, *plans must change* all the time. As a result, the JTF commander is faced with three continuously changing cycles all of which interact. SEAWAY is designed to deal with these continuously changing cycles, to accept constant changes, and to provide alerts, warnings, recommendations, and plans – and to change these as change demands.

What tools does a JFC have to deal with change? Damn few. While I was a Chief of Staff in the Pacific, we formed five real JTFs -- and each time it was a pick-up ballgame. Each time we contributed the tools we thought could help but they were pretty poor. So, SEAWAY was and is a product of frustration as well as a product of commitment and need. It must support single service, joint, and coalition operations equally and easily. As

I think you'll see during the demonstration, it can do so. And it should do so rapidly—whether generating options or assessing their supportability.

The tools in SEAWAY were also designed to assist professionals in identifying opportunity costs and assessing risks. The important word there is “help” – not do it for them. I'm probably telling some in this audience how to suck eggs, but I find that there's a widespread misunderstanding as to the difference between “opportunity cost” and “risk”. It really is important to understand the distinction. *Opportunity cost* is an action foregone as a result of your decision to execute a particular course of action. In other words, it's something you can no longer do. It is the *cost of selecting that course of action*. For instance, if I decide I'm going to shoot up 85% of all of my artillery ammunition tonight, then tomorrow morning one of the opportunity costs of that decision is an inability to provide artillery fires until I can get re-supplied. That's an opportunity cost.

It's not a risk. Risk is the likelihood that something will happen times the consequences if it does happen. Using the artillery example, if we are engaged in a United Nations support operation, firing up all the artillery rounds may have very little consequence, and hence the risk is slight. However, if we were engaged in North Korea, it would be an entirely different and far more serious risk situation. So, a good decision support tool at the Joint Task Force level should help us identify opportunity costs and certainly should assist in assessing the associated risk. Philosophically, I would never build a system that assesses risk. I would build one that provides indices and allows professionals to assume that responsibility. I continue to believe that the responsibility for risk assessment must remain squarely on the shoulders of the commander and his staff.

The graphic below presents the basic logic flow of Seaway. Many of you are thinking, “I've seen that before.” and you bet you have. It's the logic of the military planning process. First, A commander generates a notion. Then, using IPB and LPB tools in SEAWAY we can quickly generate a scheme of maneuver on an interactive battlefield. *Interactive?* What does that mean? It means that as I draw the rivers in, the agents understand that they are rivers. If I try to draw a scheme of maneuver across that river for a tank unit they will alert. They will look at that unit and tell me “Sorry, tanks don't swim. You need to find a bridge or go somewhere else.” In other words, they understand what's on that map. They understand what's in the unit. They understand the terrain and the weather. If we create a swamp and we try to go through it, they're going to adjust the rate of advance and all kinds of other things in the logistics.

So, returning to the logic flow, we generate a scheme of maneuver. First we task organize the force to be employed. SEAWAY can employ units as task forces, as individual units, or as combinations of task forces and units. It is adaptive because we have to be adaptive as we fight. It is doctrinally neutral, allowing the user to employ the force according to any doctrine that is appropriate. Just as we can create allied and friendly task forces, SEAWAY supports creating enemy task forces and then employing these. Although this capability has not been tested, everything that we're going to discuss today concerning

friendly forces can be accomplished with enemy forces, neutral forces, and allied forces. You can task organize all four, you can employ all four, and you can assess supportability, opportunity costs, and risks for all. Now, at this point I don't know where this capability is going to lead because we really haven't been able to test it yet. However, there's some real excitement about it building in the intelligence community about it.

Once we have generated a scheme of maneuver on SEAWAY's interactive battlefield, we can pose key questions aimed at assessing supportability, opportunity costs, and risk. Question one: is it supportable in terms of *inventory*? Question two: can I *deliver* it to with the transport assets I have? And, question three? *At what price* (in both cases)? The question of price focuses on opportunity costs and risks. For example, the "price" of delivery can be measured in lost operational flexibility for the joint task force. Because we're operating at a deep inland location, all logistics must be delivered by helicopter. However, maneuver also depends on helicopters – the same helicopters. That's the built in tension in emerging doctrine, especially that supporting sea basing. A tool such as SEAWAY must assist in rapidly furnishing decision support to commanders and staffs in answering the question of "*At what price?*"

A good operational planning team at I MEF can generate a scheme of maneuver in SEAWAY in about 10 or 15 minutes for a MEB of 12-15,000 troops. Once that scheme is complete, the OPT will give SEAWAY guidance on expected intensity, phases in the scheme, and other key guidance. SEAWAY will then rapidly perform several functions. First, agents will translate the *operational* scheme of maneuver into a *logistic statement of requirements* in about ten minutes. That statement is a recommendation of *what must be delivered in what quantity to what landing zones for which units in what time frame in order to support the phased scheme of maneuver* generated by the OPT.

Next, we arrive at our first major decision point. Do we have the fuel, water, food, and ammunition inventory to do it? Because SEAWAY is fully interoperable with ICODES (and hopefully with TCAIMSII when that system is proved), agents can compare what is required to execute the scheme of maneuver phase-by-phase with what is currently available and what is en route to the theater. The result is to identify the deficits, where stocks are located that could offset them, and when new stocks of the short items are due to arrive. So, as a Joint Task Force commander, at any point in time, I can see what is coming and what is here, and how well it supports my proposed course of action. Now, with agents translating operational courses of action directly into logistic requirements and comparing these with available supplies, we have given the JFC a valuable tool with which to shape the theater out perhaps thirty days.

In this process we would probably receive alerts with messages such as the fact that we don't have enough 155 to execute at the intensities we have specified. Well maybe we do and maybe we don't. You and I may know very well that we do, and that the deficit is in fact very minor. However, the agents are making recommendations based on a set of rules. Recommendations – not decisions.

Let me talk for a moment about decision support systems and the importance of *transparency*. My advice is simple: *If you can't open the hood and look at the basis for every computation and how the agents are functioning, don't buy it and don't use it.* It's that simple. I think the rule is ironclad. Don't buy it and don't use it if you can't open it up and can't look at it. Every computational basis in Seaway is transparent to the user. That's the good news. The bad news is you'd better protect access to these important files.

Once the commander has determined that the scheme of maneuver is supportable in terms of inventory, the question becomes "Can I get it there, and at what price in terms of operational flexibility?" First, we identify the assets which are available to deliver supplies and equipment. There are tools which support reserving helicopters and other delivery craft down for maintenance, to be used in assaults and other tactical operations, and various other categories used by the operating forces. SEAWAY will then load every remaining helicopter (and LCAC if these can be employed) *individually* by tail number, using the performance characteristics for that particular craft. The agents in SEAWAY will then create a detailed sortie-level phased delivery plan that exactly corresponds to the demands and the timing of the parent scheme of maneuver.

Why go to such lengths? Because SEAWAY was designed for war fighting assessment and this sort of accuracy and realism is way beyond "tonnage divided by numbers of aircraft". If I have 12 helicopters on the deck of a LHA how many of them do you think will have the same characteristics? Perhaps three? The other nine will have all different lift characteristics, and these might vary by as much as 40%. It gets better than that. What's the difference between a helicopter lifting off and LHD seaward of Wonsan in February and lifting off and LHD seaward of Wonsan in July? It may be as much as a 40% variation in payload. Heat and humidity take their toll on helicopters. So, to summarize this step, Seaway allows you to characterize and to set performance characteristics for every helicopter individually as you build the delivery plan. Agents then load each bird individually and build a sortie level plan involving multiple ships, multiple tactical bases ashore, and multiple forward landing zones. It is complex, and it ought to be for that is the nature of warfighting.

SEAWAY may take as long as twenty or twenty five minutes to generate all of the sorties and decision aids describing a delivery plan of 100 sorties or more.. We may also receive agent alerts indicating that the supplies and equipment needed for the scheme of maneuver can't be delivered in the time element which we have prescribed. In this case the agents offer us several different options designed to bring the plan into an acceptable state. We can move the sea base; we can level supplies between landing zones; we can increase transportation assets; and, if we still can't deliver the needed supplies in the timeframe required, then the course of action is unsupportable in terms of delivery. But, for the first time, because SEAWAY is distributed and collaborative, we all know it's not supportable, whether the JFC at sea, the GCE commander ashore, or the J3 over there on the top of a mountain. And, we can all see why it's unsupportable without staff meetings and endless briefings. We can all see the same explanatory screen at the same time.



What does this do to *tempo*? It can dramatically speed it up. What does it do to *adaptation* if I can now do three or four schemes of maneuver in a morning that previously took three days? What does it do to *accuracy* if we've got agents tracking hundreds of thousands of items and rapidly calculating the support for each phase in a scheme of maneuver? N75 used Seaway two weeks ago in an analysis of future LHA-R requirements. Some of the MEB delivery plans were 180 sorties long and involved several hundred thousand items for delivery.

Now. Let me pause for a minute and address how SEAWAY creates and then employs ships to build a sea base. Because ICODES is fully interoperable, agents in SEAWAY can digitally create any US ship including all service pre-positioning vessels, all L-class ships, and all black bottoms owned or leased by TRANSCOM. Additionally, for the almost 300 ships in the current system inventory, SEAWAY knows the deck cyclic rates. It knows the helicopter spots. It knows the L-CAC wells, and it knows many other characteristics, all of which may be adjusted by the user. You can increase the helicopter spots. You can increase the wet wells if you want to do all that. But the defaults are the clear values of the ships as these exist today.

SEAWAY is not designed as a current battle management tool. We're building a planning and assessment tool. So don't mix up battle management or war-gaming a current battle situation with planning and assessment. Battle management is "right now", and is essentially reactive. SEAWAY is really a set of tools designed to support the staff in performing future operations and future plans – operations to be conducted two to 30 days out. It's tools could also be used to validate and assess the extent to which an existing theater war plan could actually support a prescribed force under a specified set of operational conditions using the logistics which have been planned. There are undoubtedly many many more uses,

A question always arises on how the agents calculate the logistics for each phase in a proposed scheme of maneuver. What do the agents know as that is occurring? They know the distances and the forms of maneuver which have been prescribed (some are more consumptive than others). They know every vehicle in a unit or task force and what it consumes. They know every vehicle in a unit or task force that shoots, and what it shoots at each specified intensity. And because we gave it guidance on the scheme of maneuver, they know the expected intensities. The agents are observing and calculating constantly as we task organize, select objectives and forms of maneuver, receive weather conditions and their impacts, and provide commander's guidance. Logistics is now part of the course of action generation process rather than an inaccurate and much delayed postscript.

There are many capabilities that have been asked for in the next SEAWAY, Version 3.0. It will include the capability to generate all supporting plans for the STOM assault and a great many other things, including support not just to rotary wing aviation but also to fixed wing aviation. Other things that have been asked for that are well within the scope of this kind of technology is clicking on a river to get its flow and its width, or getting a building's

composition or many other significant intelligence –related advances. All of that can be added.

In summary, as an example of advanced adaptive decision support, SEAWAY is “different strokes for different folks”. Adaptive decision support systems should be useful tools. For the acquisition community, Seaway is being used to model future ship capabilities. The Marine Corps is looking at it from the standpoint of how to support operational maneuver from a sea base, and what kinds of formations are supportable under what kinds of condition, doing what sort of combat. The operational planning teams have used it on the West Coast to generate schemes of maneuver and to quickly assess their supportability. The combat developers at are exploring the new concepts by building schemes of maneuver under different kinds of weather and different kinds of terrain to see what they result in, and introducing new equipment, new trucks. Or, for example, a 22% reduction in fuel consumption – what does that do to free helicopters from logistics delivery missions for assault support? The impact could be enormous; a less consumptive force could have a significant impact on the helicopter requirements to support it. SEAWAY can help us get these answers and many, many more.

I thank you for your attention. Thank you very much.

